

IMPORTANT PRODUCT INFORMATION

READ THIS INFORMATION FIRST

**Product: IC693 DSM Module (“DSM314”) with Firmware Version 1.1
IC693DSM314-AB**

Introduction

Some of the information in this document is not available elsewhere, so we recommend you save it for future reference. This document covers the following subjects:

- General description of the DSM314 module.
- Special Operational Notes
- Features and Functionality notes
- Restrictions and Open Problems notes

General Description of the DSM314

Product Description

The IC693DSM314 Module (DSM314) can control up to four analog servos or two digital servos plus one analog servo. This controller also supports high speed Local Logic which allows the DSM to perform limited logical decisions and math synchronous with the position loop update rate. Local Logic also supports high speed digital output control synchronous to axis motion. The strobe position capture accuracy is significantly better than the DSM302. With the support of VersaPro 1.10 and CPU release 10.00 firmware, the DSM314 achieves single point of programming with all motion and Local Logic programs and hardware configuration stored in the PLC CPU. Programs are then transferred via the backplane to each DSM314 at power-up. The basic capabilities of the DSM314 are described below:

High Performance

- Digital Signal Processor (DSP) provides vector control of AC servos
- Servo loop update:
 - Digital mode: 250 μ sec (torque), 1 mSec (velocity), 2 mSec (position)
 - 1 Axis Analog mode, no Local Logic: 0.5 mSec (position)
 - 1 Axis Analog mode with Local Logic: 1.0 mSec (position)
 - 2 Axis Analog mode, no Local Logic: 1.0 mSec (position)
 - 2-3 Axis Analog mode with Local Logic: 2.0 mSec (position)
 - 3-4 Axis Analog mode, no Local Logic: 2.0 mSec (position)
- Block processing time under 5 mSec
- Velocity Feed Forward and Position Error Integrator to enhance tracking accuracy
- Local Logic
- Fast Backplane Status Access Read/Write Support (SVREQ #46)
- High resolution of programming units
 - Position: -536,870,912 .. +536,870,911 User Units (at 1:1 User Units / Counts)
 - Velocity: 1 .. 1,000,000 User Units / sec (at 1:1 User Units / Counts)
 - Acceleration: 1 .. 1,073,741,823 User Units / sec / sec (at 1:1 User Units / Counts)

Ease of Use

- Single Point of Programming
- Simple and powerful instruction set
- One or two axis motion programs with synchronized block start on axis 1 & axis 2
- Up to four concurrent single axis motion programs
- Integrated Motion Programming and Local Logic Programming in VersaPro
- Backplane Motion and Local Logic Program Transfer
- User scaling of programming units
- Generic programming using command parameters as operands for Acceleration, Velocity, Move and Dwell commands
- Configured with VersaPro (1.10 or later version) software
- Automatic data transfer between PLC tables and the DSM314 without user programming
- Ease of I/O connection with factory cables and terminal blocks as well as a serial port for connecting programming devices

Versatile I/O

- Control of digital AC servos & Analog servos with $\pm 10\text{v}$ Velocity Command Interface
- Home and overtravel switch inputs for each servo axis
- Two position capture strobe inputs for each position feedback input
- 5v, 24v and analog I/O for use by the PLC
- Incremental quadrature encoder input for Follower mode
- 13 bit analog output for each auxiliary axis can be controlled by PLC or used as servo tuning monitor

Product ID

IC693DSM314-AB

H/W Id: AP3B1 (44A737294-G01R03 or later)

S/W Id: Firmware version: 1.1 App. 44F725986-417AB

Firmware Update Kit

Update kit number for this firmware release (version 1.10) is 44A749487

Applicable Documents

GFK1742, *DSM314 for IC693 PLCs User's Manual*

Special Operational Notes

IC693 CPU Firmware

Use of the DSM314 requires that version 10.00 or higher of the IC693 CPU firmware be installed in the CPU module. CPU firmware version 10.00 is only available for CPUs 350, 352, 360, 363, and 364.

VersaPro

Use of DSM314 firmware version 1.0 requires that version 1.10 or higher of VersaPro be utilized to configure and program the DSM314 module. The DSM314 is not compatible with any other PLC programming software or with the DOS-based Motion Programmer software.

Essential Configuration Parameters

VersaPro configuration software version 1.10 or later must be used to configure the DSM314 module. The following configuration parameters will typically not default to the settings required for many applications and must be changed by the user or are features not available in this firmware release.

Motor1 Type, Motor2 Type:	For digital servos motor type must be changed to match the specific type number of the motor used. Select type 0 only if no servo is used or in ANALOG mode.
CAM Block Name	CAM block names are not supported in this firmware release.
Follower Disable Action	<u>Abs Position</u> is not supported in this firmware release
Analog Servo Command	<u>Torque</u> is not supported in this firmware release
Acceleration Feed Forward Percentage	<u>Acceleration Feed Forward Percentage</u> is not supported in this firmware release
Feedback Source	<u>Feedback Source</u> must use <u>default</u> or <u>Ext Quadrature Encoder</u> . <u>Ext Quadrature Encoder</u> is used with Digital Mode Axis-1 only. Other choices are not supported in this firmware release
CAM Master Source	<u>CAM Master Source</u> is not supported in this firmware release
Ramp Makeup Mode	<u>Ramp Makeup Mode</u> must use <u>Makeup Time</u> . <u>Makeup Velocity</u> is not supported in this firmware release
Ramp Makeup Velocity	<u>Ramp Makeup Velocity</u> is not supported in this firmware release
Advanced Parameters	<u>Only the first two Advanced Parameters in Hardware Configuration are</u> supported in this firmware release

PLC %Q Bits

PLC %Q bits are, by design, RETENTIVE in nature. These bits ONLY become NON-RETENTIVE after their location is used (programmed) in a PLC program. All motion-causing %Q bits such as *Drive Enable*, *Start Motion program*, *Jog*, etc. must be controlled from a "programmed" PLC coil reference for safe operation.

Grounding Bars and Clamps

The *DSM314 for IC693 PLCs User's Manual* describes the I/O cable grounding requirements required for a system to meet CE Mark installation guidelines. These guidelines include the use of grounding bars and clamps. A Grounding Bar may be ordered as part number 44B295864-001R02 and a Ground Clamp as part number A99L-0035-0001.

Cables

Two I/O, two command, and one communication cable are available for use with the DSM314, as described below. Consult the factory regarding custom length cables.

- IC693CBL324: 1 meter terminal board connection I/O cable
- IC693CBL325: 3 meter terminal board connection I/O cable
- IC800CBL001: 1 meter servo command cable
- IC800CBL002: 3 meter servo command cable
- IC693CBL316: Motion programmer communications cable

Caution

The I/O and command cables listed above are custom manufactured with special shielding and internal construction. Substituting non-approved cables may adversely affect the servo system.

Terminal Boards

Two terminal boards for user I/O connections are available for use with the DSM314, as described below.

- IC693ACC335: Servo terminal board
- IC693ACC336: Auxiliary terminal board

These terminal boards provide screw terminal connections for I/O signals such as Position Strobes, Home Switches, Limit Switches, Analog Inputs, and Analog Outputs. For additional information, refer to Chapter 3 of GFK-1742, *DSM314 for IC693 PLCs User's Manual*.

Caution

The terminal blocks contain Metal Oxide Varistor (MOV) circuit protectors, which prevent excessive electrical energy from affecting the DSM314. The maximum recommended input voltage for any of the 24v I/O circuits is 30 VDC with respect to earth ground ("S" terminal) or circuit common.

Strobe Input Differences between Analog and Digital Mode

The strobe input faceplate pins for Axis 1 and Axis 2 depend on the DSM servo mode (Analog or Digital). In Digital Mode, the Axis 1 and 2 strobe inputs use faceplate inputs IN1 and IN2, which can be either single ended or differential. In Analog mode, the Axis 1 and 2 strobe inputs use faceplate inputs IO5 and IO6, which are single ended only. Axis 3 & 4 always use IO5 and IO6 as the strobe inputs.

NOTE

The input circuits for IO5 and IO6 contain 4.7k pull-up resistors to internal +5v. If no signal is connected to these inputs, the input will always appear to be ON. Normally a single ended TTL or CMOS driver must be used to drive these circuits from the strobe sensor.

The strobe inputs are summarized in the table below.

Servo Type	Axis 1 Strobe Inputs	Axis 2 Strobe Inputs	Axis 3 Strobe Inputs	Axis 4 Strobe Inputs
Digital	IN1_A, IN2_A (Single Ended or Differential)	IN1_B, IN2_B (Single Ended or Differential)		
Analog	IO5_A, IO6_A (Single Ended)	IO5_B, IO6_B (Single Ended)	IO5_C, IO6_C (Single Ended)	IO5_D, IO6_D (Single Ended)

Problems Resolved by this Release (1.1)

None

New Features and Functionality of this Release (1.1)

External Position Feedback (DIGITAL Mode Only)

External position feedback allows the user to control the servo position loop of axis-1 from a position feedback device (Quadrature Encoder) that is different from the position encoder mounted on the motor. The standard digital servo motor feedback (from the serial encoder) will be used for motor commutation and feedback for the remaining loops.

Axis 1 in the DSM314 can be configured to use an external encoder connected to the Axis 3 "C" connector. Reference *DSM314 for IC693 PLCs User's Manual* for more details on the axis connectors. In VersaPro Hardware Configuration, the Axis 3 mode must be set to "**Auxiliary Axis**" (in the "Settings" tab). In the "Axis # 1" tab the "Feedback Source" must be set to "**Ext Quadrature Encoder**". The external feedback feature is not available for Axis 2.

NOTE

The quadrature encoder must be wired in phase with the encoder that is in use on the digital servo motor. An easy way to check the wiring for correct operation is as follows. Wire the external encoder to the module. Configure **Axis 3 Mode** as an *Auxiliary Axis*. Do not enable the **Ext Quadrature Encoder** feature for Axis 1 at this point. This simple configuration will allow the DSM to report the position read from the digital servo motor-mounted encoder (axis 1) and the external quadrature encoder (axis 3). The user should also verify that the **Axis Direction** configuration parameter for both axis 1 and axis 3 are set to *Normal*. Turn on the %Q Enable Drive bit and place the command code for Force Digital Servo Velocity to 0 in the %AQ table. Confirm that the servo amplifier is enabled (the motor should exhibit holding torque). The %Q Enable Drive bit must be maintained ON in order for the Force Digital Servo Velocity command to function. Send the command code for Force Digital Servo Velocity. The user should send a small value such that the servo motion will not harm the driven load. Confirm that the motor position reported for axis 1 and the encoder position for axis 3 have the same phase. For example: If the reported axis 1 position is positive and increasing, then the reported axis 3 position should also be positive and increasing. If the positions are out of phase (i.e. positive/negative) then reverse the encoder channel A and channel B inputs for the external encoder and repeat the above test. If this does not fix the problem, consult the documentation that came with your encoder. Once the encoder and motor feedback devices have the same phase, the user can proceed with setting up the external encoder feature.

In the tab Tuning #1, the user must enter a *Velocity at Max Cmd* value. The Velocity at Max Cmd data must be the velocity at which the external quadrature encoder would be rotating if the digital servo motor

were running at 4096 rpm. The data does not imply that the digital servo motor can run at 4096 rpm, it is only used to set up the DSM internal gain factors for position loop gain and velocity feedforward. The reader should note that the above process of setting *Velocity at Max Cmd* would need to be redone if the User Units to Counts ratio for axis 1 is changed.

The "Velocity at Max Cmd" data units are axis 1 user units/sec. The user must calculate the axis 3 encoder output in cts/sec and convert to axis 1 user units/sec. The maximum allowed value for "Velocity at Max Cmd" is 1 million cts/sec (DSM hardware and firmware limit) which is enforced by VersaPro Hardware Configuration.

When Axis 1 is configured for external feedback, the Find Home cycle will still use the 24v Home Switch input from the "A" connector even though the external encoder is connected to the "C" connector. Similarly, the Axis 1 Overtravel Limit Switch inputs will be from the "A" connector. Axis 1 strobes will use the axis 3 inputs from the "C" connector (IN5_C and IN6_C) and are subject to analog strobe timing specifications. Axis 3 strobe will not operate, although the level of the axis 3 strobe inputs will still be reported to Local Logic and CTL bits.

NOTE

External quadrature encoders which have the same resolution as the digital servo motor's serial encoder (8192 cts/rev) cannot be configured properly if they are geared to run more than 1.7x faster than the digital servo motor. External quadrature encoders geared at 1:1 with the digital servo motor cannot have resolution greater than about 14,000 cts/rev.

Features and Functionality of Release 1.0 (Initial Release)

Local Logic Programming

The DSM314 includes Local Logic capability. The Local Logic program works in conjunction with the PLC logic program and motion program to yield a flexible programming environment. Specifically, Local Logic programs provide the user with the ability to perform math and logic that is deterministic and synchronized with the DSM Position Loop execution rate. This ability is critical to many applications where the accuracy and/or speed require this tight synchronization. *In release 1.0, some Local Logic variables are not extended to Axis 3 or 4. Consult the User's Manual (GFK-1742) or VersaPro Local Logic Variable Table for more information.*

Follower Configuration and Sources

The DSM314 supports a virtual (time based) Auxiliary master axis that can be configured in place of one or more of the controlled axes. Other axes on the same module can be independently configured to follow this virtual axis or a real encoder master. Other follower mode enhancements include:

- User defined units can be used in follower mode
- An independent acceleration setting is now available for follower make-up move
- Registration move option added to follower disable action list (incremental position)
- Separate %I bit to indicate the follower ramp is active
- Configurable follower enable and disable triggers

4 Axis Analog/ 2 Axis Digital Servo and 1 Axis Analog Control

The DSM314 provides the user with 4 Axis Analog Servo or 2 Axis Digital Servo Control plus an additional Analog axis.

Improved Strobe Resolution

Strobe resolution is +/- 2 counts with 10 microsecond of additional variance. If a strobe occurs during

extreme accelerations, the resolution will decrease slightly.

Single Point of Programming with VersaPro 1.10

The motion programming tool suite is integrated into the VersaPro programming and configuration package. All module programming occurs through this package. No additional connections, other than the CPU connection, are required.

Incremental Encoder Support

Set Position is allowed on the first revolution when digital servos are configured for incremental mode.

Fast Backplane Status Access Functionality

The Fast Backplane Status Access function (Service Request #46) provides another PLC sweep mode. In this sweep mode, the CPU transfer a limited amount of digital I/O information to and from the module(s). Thus, sweep times can be decreased during certain critical sections. The backplane Fast Backplane Status Access function will write 4 bits to, and read 8 bits from the DSM314.

Position Loop Update Rate

The DSM314 will dynamically adjust the position loop update rate for optimal performance based on the number and type of axes configured:

- 2 ms if Any Axis is Digital or 3-4 Axes Analog or 2 Axis Analog with Local Logic
- 1 ms for 2 Axis Analog (no Local Logic)
- 1 ms for 1 Axis Analog (with Local Logic)
- 0.5 ms for 1 Axis Analog (no Local Logic)

Backplane Motion and Local Logic Program Transfer

Each time the PLC powers-up, the DSM314 programs are loaded via the backplane to each module. This allows multiple DSM314 modules to share the same program and also allows swapping DSM314 modules during troubleshooting without transferring programs.

Enhanced I/O Assignment

- All I/O references are identical for each of the 4 axes
- Output arbitration between PLC control and Local Logic program control can be configured by the user
- There are 32 CTL bits
- CTL bits and output bit assignments are configurable

Enhanced Parameter Resolution and Ranges vs. DSM302

Resolution Changes:

- Position Loop Time Constant: From 1ms in the DSM302 to 0.1ms in the DSM314
- Velocity Feedforward: From 1% in the DSM302 to 0.01% in the DSM314
- Torque Limit AQ Command: From 1% in the DSM302 to 0.01% in the DSM314

Range Changes:

- Position Range: Increased from -8,388,608/+8,388,607 User Units (UU) in the DSM302 to -536,870,912 / +536,870,911 UU in the DSM314
- Accel Range: Increased from 134,217,727 User Units per Seconds Squared (UU/S²) in the DSM302 to 1,073,741,823 UU/S² in the DSM314

Parameter Based Subroutine Calls

Motion program subroutine calls can be dynamically altered by using parameter-based references instead of the fixed references.

In-Zone Bit Based on Position Error Only

In the DSM302, the *In-Zone* %I bit was controlled by the *Position Error* status and the *Moving* %I bit. In the DSM314, the *In-Zone* %I bit is controlled only by the *Position Error* status, allowing this bit to be used to determine if an axis is accurately following the command during a move.

Reversal Compensation Changes

The reversal compensation value is not reflected in the commanded position or actual position values, allowing a more accurate determination of axis position in systems with backlash.

Restrictions and Open Problems

Restriction/Problem	Description
<i>Inconsistent operation of Absolute Rotary Mode</i>	When the configuration for Software EOT is set to disabled and the DSM is in rotary mode, commanded position and actual position are allowed to roll over at the configured limits. An Absolute mode %AQ move command works as expected – the axis always moves within 1 rev to the absolute position specified in the command. However, if a motion program with a combination of incremental and absolute moves is used, an absolute move may cause unexpected results - the axis may move many revs when the user expected it to move only within one revolution. If %AQ move commands are used instead of a motion program, the axis works as expected.
<i>Select analog output mode cannot be sent from axis 4 %AQ command registers</i>	The Select Analog Output mode command (%AQ command 47h) can only be sent from the %AQ command registers for Axis 1-3. If the command is sent in the axis 4 command registers, it will not have any effect.
<i>Follower Registration Move is referenced to previous cycle</i>	When a Follower registration move (Follower Disable mode = Inc Position) is initiated by a faceplate input (CTL bit), the actual registration distance relative to the position at the instant the faceplate input turns on is 0-2 ms less than the programmed registration distance. The only noticeable effect will be on a Local Logic program, which corrects for 2 ms sampling variations using slave axis strobe data and the Local Logic position increment command. The strobe position must be compared to the Actual Position of the cycle before the strobe, rather than the cycle after the strobe.

Additions to PLC Manuals

The following information will be added to the applicable PLC manuals (System and Reference manuals) when they are next revised. Once added to the manuals, it will be removed from following versions of this IPI.

DSM314 Scan Time Contribution

The table below lists how many milliseconds the DSM314 adds to PLC scan time. The amount of scan time contribution is related to (1) the number of DSM314 axes configured, and (2) the type of rack (main, expansion, or remote) the DSM314 is mounted in.

Note

Be aware that the DSM314's internal Local Logic engine has a maximum scan time of 2 ms that is independent of the PLC scan; therefore, time-critical, motion-related I/O should be handled in the Local Logic program rather than in the PLC ladder program. See the DSM314 User's Manual for details on Local Logic programming.

No. of Axes Configured	DSM314 Scan Time Contribution (in Milliseconds)		
	Main Rack	Expansion Rack	Remote Rack
1	1.6	2.6	6.9
2	2.2	3.8	9.9
3	2.8	4.3	13.0
4	3.3	5.2	15.9